

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY.

THE SERUM TREATMENT OF SWINE PLAGUE
AND HOG CHOLERA.

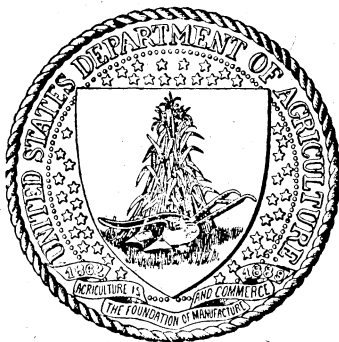
BY

E. A. de SCHWEINITZ, Ph. D., M. D.,
Chief of Biochemic Division,

WITH THE COLLABORATION OF MARION DORSET, M. D.,

UNDER THE SUPERVISION OF

D. E. SALMON, D. V. M.,
Chief of the Bureau.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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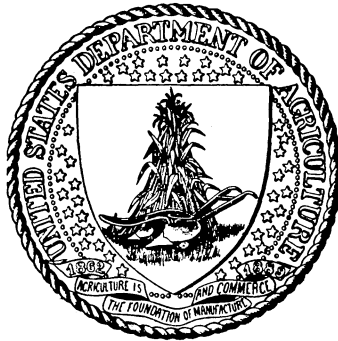
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., December 24, 1898.

SIR: Laboratory investigations in the use of serum for treating hog cholera and swine plague have been carried on by this Bureau for several years, and with such favorable results that, upon your direction, the treatment was given an enlarged field in Page County, Iowa. The work conducted there during the season of 1897 showed that the treatment saved about 80 per cent of the animals injected. The results in 1898 have been exceedingly satisfactory and tend to confirm those of the previous year. So much interest has been manifested in this work that this article on the subject of serum treatment for hog cholera and swine plague has been prepared by Dr. de Schweinitz, who has been in charge of the work, assisted by Dr. Marion Dorset, and others, and its publication as a bulletin of this Bureau is recommended.

The public should be informed that the preparation of the serum by the Bureau is necessarily limited, and therefore its distribution is confined to inspectors for the Bureau and to experiment stations.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.

TABLE OF CONTENTS.

	Page.
Preliminary experiments	5
Results of experiments with serum as a curative agent	7
The preparation of the serum	10
The preparation of a mixed serum	12
Character of immunity	12
Difficulties of field work	12
Practical work in Page County in 1897 and 1898	13
Expense of the serum preparation	17
Sources of infection	17
Necessity of disinfection	17
Legal supervision of the preparation of serum	18

THE SERUM TREATMENT FOR SWINE PLAGUE AND HOG CHOLERA.

By E. A. DE SCHWEINITZ, Ph. D., M. D.,
Chief of Biochemic Division.

One of the most interesting and difficult problems which has engaged the attention of this Bureau for some years has been the discovery of a method or methods for the prevention or cure of diseases known as *hog cholera* and *swine plague* among swine.

PRELIMINARY EXPERIMENTS.

In the year 1890 a study of the substances secreted by the hog cholera and swine plague germs was begun in the Biochemic Laboratory of the Bureau of Animal Industry by the writer of this article. From cultures of these bacteria he succeeded in isolating two substances albuminoid in character and others belonging to the group called amines, which produced, when injected into experimental animals, some of the characteristic symptoms of hog cholera or swine plague, respectively, and conferred upon these animals an immunity to subcutaneous inoculation with hog cholera and swine plague germs, respectively. The reports of this work were published in the Medical News of Philadelphia in September and October, 1890, and annual reports of this Department for 1890 and 1891.

A series of practical experiments was then carried on at the experiment station of the Bureau upon swine. The animals were injected with the products of the growth of these bacteria, including the contents of the cells themselves, as well as those products of excretion of the cells which were in solution in the culture liquid. In ten days after inoculation they were exposed to hog cholera and swine plague, respectively, by an intravenous inoculation with a virulent germ sufficient in quantity to kill the check animals in a week to ten days. In general these results were fairly satisfactory, in so far that, while the check animals died, about 50 per cent of the treated animals remained alive. The method of exposure, however, was unsatisfactory, as it was not always possible to be certain that the checks would die, and in a good many cases the exposure of the treated animals by this method of inoculation was very much more severe than that which they would in all probability have been subjected to in the field. In addition, the injection of these products of the bacilli produced disagreeable local lesions in the animals.

While the results of the work showed that considerable immunity to these diseases could be secured by this method of treatment, it did not appear practicable for field work, and consequently other laboratory investigations were begun.

A more thorough study of the substances produced by the hog cholera germs, the results of which were published in the Philadelphia Medical News of October, 1892, showed that if the cultures of this germ were made upon milk or other suitable media, it was possible to obtain from these cultures a small quantity of enzymes, or soluble ferments. These ferments secreted by the hog cholera bacillus were also tried for the purpose of producing immunity in experimental animals, with satisfactory results. The injection of quantities of these ferments below 0.01 of a gram was without ill effect. If the amount injected was increased beyond this point there was a rise of temperature in the animals for several days, and in several instances 0.05 of a gram was sufficient to kill the animals. A single injection of guinea-pigs with 0.04 of a gram of the ferments served to make the animals immune to an inoculation with the hog cholera germ that was sufficient to cause the death of the checks in ten days. In the article referred to the opinion was expressed that the soluble ferments exert a very potent action in rendering animals insusceptible to disease, and that to the indirect action of the specific ferments secreted by the hog cholera and other germs the protective and curative influence of blood serum from immune animals may be traced, as well as the immunity produced by injecting animals with cell contents or the products of the cell growth. At about that time the writer published an article in the Philadelphia Medical News, September 24, 1892, upon the production of immunity in guinea-pigs to hog cholera by the use of blood serum from other guinea pigs that had been previously immunized. The guinea-pigs used as a source for the blood serum were immunized by means of the cell contents and products of the growth of hog cholera bacilli, and after they had withstood an inoculation of the germ of sufficient virulence to cause the death of the checks they served as a source of serum to be used for injecting other healthy guinea-pigs or for treating guinea-pigs infected with hog cholera. The results of these experiments were also satisfactory, but for various reasons they could not be pushed as rapidly as desired. The experiments were continued, however, in a quiet way, and the use of the products of other bacteria allied to the hog cholera germ, as the *Coli communis*, etc., were tried. The results were satisfactory for the purpose of securing immunity to hog cholera. As stated in one of the papers mentioned, it is probable that all gas-producing bacilli secrete a soluble ferment, and that this ferment is of considerable importance in connection with the production of immunity. While it is not probable that each germ gives rise to a distinctive ferment, it is probable that different germs secrete two or more ferments, and that the combined action of these ferments is necessary for securing satisfactory results in immunity.

RESULTS OF EXPERIMENTS WITH SERUM AS A CURATIVE AGENT.

During the years 1893, 1894, and 1895 it was possible to make some more experiments with the serum as a curative agent for hog cholera and swine plague upon a somewhat larger scale. These experiments were reported to the Society for the Promotion of Agricultural Science in Buffalo, N. Y., in August, 1896, and published in their proceedings, in the New York Medical Journal, September 5, 1896, and in Centralbl. f. bakt. u. Parasit., Vol. XX, No. 16-17, 1896.

The animals used for the production of the serum were treated for me by Dr. Schroeder, in charge of the experiment station of the Bureau.

After several months' injection of the cows with the virulent hog cholera culture, the serum was tested. The following is a record of one of the experiments:

Guinea-pigs injected with serum from treated cows.

March 9, 1894, No. 219, weight 17 ozs., received 1.5 c. c. of serum.

March 9, 1894, No. 220, weight 12 ozs., received 1.5 c. c. of serum.

March 9, 1894, No. 221, weight 11 ozs., received 1.5 c. c. of serum.

March 9, 1894, No. 222, weight 17 ozs., received 1.5 c. c. of serum.

March 18, 1894, No. 219, weight 18 ozs., received 3 c. c. of serum.

March 18, 1894, No. 220, weight 11 ozs., received 3 c. c. of serum.

March 18, 1894, No. 222, weight 19 ozs., received 3 c. c. of serum.

March 18, 1894, No. 223, weight 14 ozs., received 3 c. c. of serum.

No. 221 was found dead from pneumonia on March 16.

On March 20 No. 220 was found dead from pneumonia.

March 23, 1894, No. 219, weight 17 ozs., received 1.5 c. c. of serum.

March 23, 1894, No. 222, weight 17 ozs., received 3 c. c. of serum.

March 23, 1894, No. 242, weight 10½ ozs., received 3 c. c. of serum.

March 23, 1894, No. 243, weight 10½ ozs., received 3 c. c. of serum.

March 23, 1894, No. 246, weight 9½ ozs., received 3 c. c. of serum.

March 28, 1894, No. 219, weight 18 ozs., received 4.5 c. c. of serum.

March 28, 1894, No. 222, weight 18 ozs., received 6 c. c. of serum.

March 28, 1894, No. 223, weight 13 ozs., received 4 c. c. of serum.

March 28, 1894, No. 242, weight 12 ozs., received 3 c. c. of serum.

March 28, 1894, No. 243, weight 12 ozs., received 3 c. c. of serum.

March 28, 1894, No. 246, weight 11 ozs., received 3 c. c. of serum.

On April 9 the following guinea-pigs were inoculated with one-tenth cubic centimeter of peptonized beef-broth hog cholera culture each:

No. 219, weight 23 ozs.

No. 222, weight 18 ozs.

No. 223, weight 12 ozs.

No. 242, weight 13 ozs.

No. 243, weight 13 ozs.

No. 246, weight 12 ozs.

No. 261, weight 12 ozs.

No. 262, weight 15 ozs.

No. 263, weight 20 ozs.

No. 264, weight 14 ozs.

No. 241, weight 15 ozs. (check).

No. 260, weight 12 ozs. (check).

Nos. 261, 262, 263, and 264 had not received previous injections with serum; 241 and 260 were checks; while the other animals had been treated with serum, as above noted.

April 11, No. 261 received 3 c. c. of serum.
 April 11, No. 262 received 3 c. c. of serum.
 April 11, No. 263 received 5 c. c. of serum.
 April 11, No. 264 received 4.5 c. c. of serum.
 April 14, No. 261 received 3 c. c. of serum.
 April 14, No. 262 received 3 c. c. of serum.
 April 14, No. 263 received 4.5 c. c. of serum.

The results: April 17, No. 260 (check) was found dead from hog cholera; April 19, No. 222 was found dead from hog cholera; April 20, No. 264 was found dead from hog cholera; April 25, No. 241 (check) was found dead from hog cholera; Nos. 219, 223, and 261 were also found dead from pneumonia. There had been quite an outbreak of pneumonia among the guinea-pigs just at this time, accounting for these lesions which were not due to cholera.

Of the entire number of pigs treated, therefore, the checks died in from 8 to 16 days. Three of the pigs that had previously been vaccinated with 6 c. c. of serum each recovered and two of the pigs that had received 6 and 8 c. c. of serum two days after the inoculation with the germ recovered from the disease. These experiments repeated later showed that while the blood contained a curative and protective substance the quantity present at the time would not cure disease by the injection of several small doses. Subsequently, by continued treatment of the animals, the curative material was increased in quantity, as will be seen from experiments reported later.

Already in 1894 some work had been done which served to emphasize the close relationship between the products in artificial media of the growth of the hog cholera germ and those produced by the growth of the bacillus *Coli communis* (the ordinary intestinal bacillus). A pig which had been immunized to hog cholera by long-continued injections of the *Coli communis* and subsequently inoculated with the hog cholera germs was used as a source for the serum for treating guinea-pigs, as follows:

No. 425, weight 11 ozs., received 3 c. c. of serum.
 No. 426, weight 9 ozs., received 4.5 c. c. of serum.
 No. 422, weight 9 ozs., received 0.5 c. c. of serum.
 No. 423, weight 11 ozs., received 1.5 c. c. of serum.
 No. 424, weight 8 ozs., received 2 c. c. of serum.

Fifteen days afterward these pigs and two checks, Nos. 442 and 443, were inoculated with one-tenth cubic centimeter of a peptonized beef-broth hog cholera culture one day old. Seven and 10 days,

respectively, after this inoculation the checks were found dead from hog cholera while the other guinea-pigs remained well. These experiments repeated upon another set of animals gave about the same results, which showed that an immunizing substance is produced in the blood of a hog that is protected against the cholera. Another set of experiments, the details of which need not be reported here, showed that while the hog itself might be immune to disease, its blood serum may have lost the power of conferring immunity upon other animals. This confirms the conclusion with reference to the use of blood serum in other diseases, namely, that the immunizing principle in the blood serum can best be obtained if the animals are inoculated from time to time with the culture, or toxins. So long as the animal receives continued injection of the cell contents or products of the germ the immunity of that particular animal continues, and in addition the antitoxic substance is found in the blood. After some time the antitoxic substance may no longer be noted in the blood, or only in small amounts, while the immunity of the individual animal from which this blood is obtained may still continue. The antitoxic substances are apparently the products of cell activity only.

These experiments with the serum of immune hogs and the serum of cattle and horses that had been made artificially immune warranted further investigation.

In practice, however, it is found that hogs are exposed not only to the disease of hog cholera but also to another disease called swine plague, both of which may occur together in the same animal, or there may be an outbreak of one or the other disease alone. As the experiments made in 1891 with the products of the swine plague germ as obtained from artificial media had shown that these could be used as immunizing agents it was very reasonable to suppose, when the nature of the disease swine plague is considered, that an antitoxic¹ serum for this disease might also be obtained. A cow was used as the source of the serum after she had been repeatedly inoculated with cultures of the swine plague germ. The preliminary tests of this serum were made upon rabbits. One-tenth cubic centimeter of a peptonized beef-broth culture of the swine plague sufficient to kill a rabbit in fifteen to eighteen hours was used. Several sets of experiments showed that while the check rabbits were killed within the specified time by the swine plague cultures, others could be kept alive from six to ten days longer than the checks by the injection of 9 c. c. of the serum per pound weight. As these results indicated that antitoxic, or curative, substances were present in the serum, its

¹ The word antitoxic is used in this article in the sense of curative.

effect was tried upon guinea-pigs. One-tenth cubic centimeter of swine plague culture was used, sufficient to kill the animals. The experiments gave the following:

- No. 348 (check), weight 12 ozs., received 0.1 c. c. swine plague culture.
 No. 349, weight 8 ozs., received 0.1 c. c. swine plague culture and 3 c. c. serum.
 No. 350 (check), weight 11 ozs., received 0.1 c. c. swine plague culture.
 No. 351, weight 9 ozs., received 0.1 c. c. swine plague culture and 6 c. c. serum.
 No. 352, weight 8 ozs., received 0.1 c. c. swine plague culture and 6 c. c. serum.

While the check animal died the pigs which received the antitoxic serum recovered, about 6 c. c. per pound weight being required to check the disease.

With the assistance of Dr. Dorset I next endeavored to isolate the antitoxic principle contained in the serum, according to a method prescribed by Brieger and Boer¹ for the isolation of diphtheria antitoxin, by the use of zinc sulphate, repeated solution in sodium hydrate and precipitation with CO₂. In this way from 90 c. c. of serum about 0.152 gram of a practically ash-free white powder was obtained. The antitoxic properties of this substance when tested proved to be about the same as those of the serum. As we had therefore a serum which exhibited antitoxic, or curative, properties for hog cholera, and another which exhibited antitoxic, or curative, properties for swine plague, it was of interest to see if these serums would be of use interchangeably. The result showed, however, that the hog cholera serum protected guinea-pigs from the cholera germ but not from the swine plague germ, and that the swine plague serum protected or cured guinea-pigs from infection with the swine plague germ but not from the hog cholera germ. This demonstrated again the independent character of these two diseases, attention to which has often been drawn in previously published work.

As the preliminary experiments so far reported had shown that specific antitoxic serums for hog cholera and swine plague could be obtained, the work was carried forward on a somewhat larger scale, and serums secured which were effective in much smaller doses upon experimental animals. The laboratory results seemed to warrant a trial of this method in the field, and experiments were made during the summer and fall of 1897 on this line in Page County, Iowa.

THE PREPARATION OF THE SERUM.

In preparing the serum for this work we have used cattle, horses, mules, donkeys, etc.; the animals received injections of the filtered, sterile, or live cultures of the hog cholera germ and swine plague germ, respectively, or the solutions of their products, including cell contents, extracts, and secretions. These injections were made

¹Zeit. für Hyg. u. Infectiouskrank., Bd. XXI, Pt. 2.

either subcutaneously, intravenously, or intra-abdominally, or a combination of two or more of these methods, depending upon the results obtained. The quantities given at first were small, but increased gradually until large amounts of the material used could be injected without bad results. This treatment of the animals must be carried out very carefully and requires six to eight months' time before the serum is sufficiently potent to be of any practical use. As the treatment continues the power of the serum to check the motility of the hog cholera germ increases with rapidity. The serum of animals treated with swine plague cultures also sometimes checks the motility of the hog cholera germ. The value of the serum was determined by the amount of serum necessary to protect or cure guinea-pigs from an inoculation with the hog cholera germ or swine plague germ sufficiently virulent to kill the check animals in the usual time—a week to ten days.

The details of the method of treating these animals for preparing the serum, which were the results of numerous conferences between Dr. Schroeder, in charge of the experiment station, and the writer, will be given in another publication. Too much care can not be observed in selecting the animals and in observing proper precautions during the injections with the different products of the cultures that are used for producing in the animals a curative serum. The testing of the serum, as already noted, was usually made by treating animals that had been previously inoculated with a fatal dose of the culture. This method of testing is sometimes not altogether satisfactory so far as the cholera germ is concerned, although the results given with the swine plague are quite satisfactory. We have therefore used another method, namely, the injection of a quantity of the products of the hog cholera germ sufficient in quantity to kill the check guinea-pigs, while the other guinea-pigs so injected and treated with the serum will not succumb. This method promises more satisfactory results, and a better basis can thus be secured for estimating the amount of curative serum which should be used for injecting large animals.

In order to keep and utilize large quantities of serum, we have found it very convenient to concentrate it, and by making use of well-known principles we have accomplished this by freezing, so that a more concentrated material can be obtained and a less quantity of serum used for injecting animals. The preparation of a solid serum or an extract from the serum of the active products, secured by means of precipitation, has already been referred to, but for practical purposes it would appear that a concentrated serum is the best product to place in the hands of the individual veterinarian. If our experiments, continued on a still larger scale, give as satisfactory results as those obtained during the years 1897 and 1898 (and there is every reason to hope that such will be the case) it would appear

that we have at hand a practical method which may be used for decreasing very materially one of the most serious losses to which the farmer is subjected.

THE PREPARATION OF A MIXED SERUM FOR THE TREATMENT OF HOG CHOLERA AND SWINE PLAGUE.

The experiments had shown that the serum prepared for the purpose of curing hog cholera was useful in protecting or curing small experimental animals from hog cholera only, and that serum prepared for the purposes of curing swine plague was useful in protecting from swine plague only. Other work had shown that if experimental animals infected with hog cholera were treated with a mixture of anti-hog cholera and anti-swine plague serum, that they responded generally a little bit more quickly to the treatment. Efforts were made therefore to prepare in one and the same animal a double serum, as it may be called. In order to do this, the animals which were to serve as a source for the serum were injected with hog cholera cultures and swine plague cultures, or their products, alternately or together, the doses being gradually increased until enough had been injected to impart to the serum the desired properties. The first tests upon experimental animals showed that a serum could be obtained in this way which exerted slight curative properties for both hog cholera and swine plague. The serum, however, was more active in checking swine plague than in checking hog cholera. The treated animals did not thrive under this treatment. The work, however, indicated the possibility of perhaps producing in the same animal a serum which may be specific for two distinct diseases. Experiments are being made now to ascertain to what extent this principle can be utilized in connection with other diseases of men and animals, especially tuberculosis.

CHARACTER OF IMMUNITY.

The length of immunity produced by the injection of serum is short and more permanent immunity can apparently be secured by using in addition to serum the products of the germs. The serum has appeared most efficacious in treating herds where the disease had just begun.

DIFFICULTIES IN FIELD WORK.

A very important difficulty which is encountered in field work is that it is almost impossible to determine in the field whether animals are suffering from hog cholera or swine plague, or from a mixed infection, unless a careful autopsy has been made. And even when this is done, on account of the similarity of many of the lesions found

in the two diseases, it is necessary to resort to a careful bacteriological examination of the cultures obtained from these animals in order to decide whether the disease dealt with is hog cholera or swine plague. This has already been pointed out in previous publications of this Bureau. On account of this practical difficulty the idea very naturally suggested itself that it would be well to treat animals in the field with a curative serum for hog cholera mixed with a curative serum for swine plague obtained from different animals or with a mixed serum produced in the same animal, as has already been noted. The quantity of the serum used for treating pigs weighing from 40 to 60 pounds was 10 c. c. When they were heavier a larger quantity was used. In general, in the experimental as well as the practical work that has been done by the Bureau, a single injection of the serum was all that was given to each animal. Unless the serum to be used for this work is of such strength that one-half to 1 c. c. of it will protect a 500-gram guinea-pig from a fatal inoculation with hog cholera or swine plague it is not suitable for practical work.

WORK IN PAGE COUNTY, IOWA, IN 1897.

The Secretary of Agriculture requested the Governor of Iowa to designate a county of the State of Iowa in which he would like to have experimental work carried on by the Bureau of Animal Industry. The Governor selected Page County. The serum for treatment was prepared according to the methods that have been previously noted, conjointly under the direction of Dr. Schroeder, in charge of the experiment station of the Bureau of Animal Industry, at Washington, and the writer, in charge of the Biochemic Laboratory. The field work in Page County was in direct charge of Dr. Marion Dorset. The methods of treatment used were the following: Sick animals were inoculated with serum that had been found in the laboratory to be effective against either hog cholera or swine plague, or the swine were inoculated with mixed serums, or they were inoculated with the serums to which had been added the products of the hog cholera and swine plague bacteria and their cell contents, or cultures in which the germs had been killed without the application of heat, that might in any way have affected the secretions of the germ.

In order properly to note the efficiency of field work of this sort it is very important that a large number of checks should be preserved. To accomplish this in some instances a portion of the treated herd was reserved and not given serum. In other instances herds in which disease existed of about the same virulence as that in the treated herd were left as checks.

The conditions under which animals are placed in all diseases of course influence very greatly the results of the methods of treatment used. A child sick with diphtheria may be given an injection of

antitoxic serum, but if after this injections the child is otherwise neglected it will in all probability not recover, as while the antitoxin counteracts the specific poisons of the diphtheria germ it does not give the further stimulation to the system which is also necessary for recovery. The case is similar in the diseases of animals. They should also be given proper care as to food, water, proper housing, and a modern degree of cleanliness if any method of treatment whatsoever is to prove satisfactory. Very often the farmer has himself to blame quite as much as an outbreak of some particular disease for the loss which takes place in his herd. If he treats his animals as inanimate he must not be surprised if they finally become inanimate, nor can he hope that when they are almost dead the administration of some remedy will miraculously serve to revive them. In many instances where the animals used in this work were treated the farms were in a very good condition and the owner exhibited a sufficient amount of interest, care, and intelligence to warrant successful results. In other cases the farms were very poor and the farmers seemed indifferent as to whether their hogs had anything to eat or drink for two or three days. In order therefore to give the fairest test possible to the method of serum treatment, the better farms were the ones reserved for checks.

FIELD WORK IN 1897.

To give the general results with the work carried out under the direction of Dr. Dorset, it may be stated that out of 196 animals treated with the mixed serums 161 were saved, or about 82 per cent. The disease existed on all of the farms where treatment was carried out, a number of animals had already died, and about 50 per cent of the animals treated were ill at the time of injection with the serum. In the check herds there were originally 429 animals, and the disease had begun both in these check herds and in the treated herds about the same time. In the herds, which were not treated, only about 15 per cent of the animals recovered. Comparing these two sets it would appear that the serum had reduced the mortality about 67 per cent. It is understood, of course, that all of the animals were under the same conditions after treatment as before. As a rule, the animals appeared to begin to improve very shortly after the injection of the serum. One herd was treated with a culture alone without any serum. Only 40 per cent of the herd so treated was saved. In another case a herd which was in a very poor condition at the time of inoculation was treated with a mixed swine plague serum and a dead culture. Eighty per cent of these animals were saved, while in a third similar case where the condition of the animals was very poor, only 30 per cent was saved. These results, obtained under rather adverse conditions, indicated that

serum injection for swine diseases could be practiced with a fair degree of success when the animals are intelligently treated with a mixed hog cholera serum and swine plague serum and bacterial products, provided these serums are active. The material used in this way is perfectly harmless, so that a farmer need have no fear whatsoever in allowing his animals to be injected; if it should happen not to effect the desired cure it will not injure the animal in the slightest degree. In general, of course, the sooner the treatment of sick animals can be begun the better will be the results of the treatment, but unless the reliability of the serum has been carefully tested and established experimentally, it does not necessarily follow that a sick animal which has been injected with a serum that is said to be efficacious will be cured. If in the case of diphtheria the mortality has been reduced 50 per cent by the serum treatment after long years of careful trial with thousands of cases, it is fair to assume that this method of treatment of swine disease is worthy of a more extensive practical experiment.

The character of the disease in the animals treated, as well as in the check herds in the year 1897, was determined by careful autopsy or, so far as possible, by the identification of the cultures made from the diseased organs of some of the animals upon which autopsy had been performed. In most of the cases examined the hog cholera germ was found present, and specimens of blood which were examined for me by Dr. Dawson, assistant in the Division of Animal Pathology of this Department, gave the characteristic reaction. The checking of the motility of the hog cholera bacilli, a reaction similar to that used for diagnosing typhoid fever, as has been suggested, might perhaps be useful in determining the character of diseases among swine in the field in a quicker way than would be possible if it was necessary always to work out the nature of the culture. While the majority of these blood examinations agreed with the culture tests, in a few instances the characteristic checking of the motility was observed in blood taken from animals which undoubtedly died from swine plague. These animals may have had in addition, however, a slight infection with hog cholera. At any rate, in chronic cases of disease in swine, when it is sometimes difficult to succeed in transferring to the laboratory a virulent culture from the diseased animals, it is probable that the blood test may be of service as a diagnostic agent.

So long as a serum is being used which has curative properties for both of the diseases to which the animals in the field are usually subjected, it is not of so much importance to be able to make a positive diagnosis or distinction between the two diseases. The acuteness of the attack is perhaps of more importance, as it serves to indicate the amount of serum which should be used in treating animals.

FIELD WORK IN 1898.

As the laboratory experiments and the field work of 1897 already reported had given such encouraging results, at the request of The Hon. James Wilson, Secretary of Agriculture, Congress made a larger appropriation which should be utilized during the year 1898 for making more thorough practical tests of this curative serum for swine. Unfortunately this appropriation was not made available as early as desirable. It was necessary after the needed funds were secured to erect additional stables to accommodate the large number of animals at the experiment station of the Bureau, to purchase the animals and other necessary facilities for carrying on the the work. The experimental work in preparing the serum therefore could not be begun before the first of June, and consequently the amount of serum ready for use in the fall of 1898 was not so large as we had hoped, or as it might have been if the appropriation had been available three or four months earlier, when it was requested. Nevertheless, the field work was resumed again in Page County, Iowa. In July, Dr. McBirney, an inspector on the Bureau force, was put in charge of the work in that county, after being given instructions from the laboratory as to the quantity of serum to be used, the method of using it, the manner of treating herds, the method of keeping records, and so on. This work was carried out very faithfully by Dr. McBirney, according to the general directions furnished him, and the results reported up to date (December 1, 1898) have been exceedingly satisfactory and tend to confirm the results obtained in the year 1897. Between the 13th of July and the 11th of November, Dr. McBirney treated 35 herds containing 1,727 animals. Of these treated animals 403 died—a loss of 23.16 per cent in the treated herds. Cultures and specimens of blood were sent to the laboratory from most of these herds, and in 17 of the herds the presence of the hog cholera germ was demonstrated by tests upon experimental animals as well as by a careful study of the cultures. In 3 the presence of the swine plague germ was demonstrated. The examination of the blood and the motility test confirmed the presence of either hog cholera or swine plague, and indicated its presence in some of the herds the cultures from which had not given positive results. Autopsies were made upon one or more animals in each of these herds and records carefully kept. They indicated in many instances the presence of acute or chronic hog cholera, in a few cases swine plague, or a combination of both diseases.

Thirty-three herds in whole or in part were reserved as checks upon those which were treated. In some of these herds the character of the disease was also demonstrated by cultures or blood reactions. In others the autopsy indicated the character of the disease and hog cholera was found predominant. The number of animals in

these check herds was 3,197. Of these only 600 survived, or 81.24 per cent was lost. This shows about as large a percentage of animals saved in the treated herds as were lost in the nontreated herds and leaves apparently but little doubt as to the efficacy of practical treatment of swine diseases in the field by the use of these mixed serums alone or with bacterial products, combined with simple methods of disinfection and slight care which every farmer should be willing to give to his animals. The serum is intended to cure disease simply, and should have such aids as clean, warm quarters and good food and water; it is no protection against freezing, smothering, or starvation.

The results of our work so far warrant the following conclusions: Animals treated with the hog cholera germs, their cell contents and secretions, or those of allied germs, yield a serum which has curative properties for hog cholera. Similar results are obtained for swine plague by the treatment of animals with the germs or their cell contents and secretions.

The most satisfactory results in field work have been secured by treating the swine with a curative serum for swine plague mixed with a curative serum for hog cholera.

LOSSES FROM HOG CHOLERA AND SWINE PLAGUE.

It is estimated that the State of Iowa alone loses \$15,000,000 per year in the number of hogs that die from disease. The work, which has been carried on as above reported, indicates that at least \$11,000,000 of this loss might be avoided at a comparatively slight cost.

EXPENSE OF THE METHOD OF PREPARING AND USING SERUM.

The farmer should be able to have his hogs injected at a cost not to exceed 15 cents per head if the material for this purpose is prepared in a careful and legitimate way—for the benefit of the farmer rather than for the benefit of the manufacturer. If the latter simply desires to reap financial profits, irrespective of the fact that his material may or may not be useful, the results will undoubtedly be disastrous. Fifteen cents per head is but a trifle to the farmer if he is thereby enabled to save 60 to 80 per cent of his animals which would otherwise be lost.

SOURCES OF INFECTION AND NECESSITY OF DISINFECTION.

The fact that the cause of infection can be carried from one farm to another by animals, by birds, by water running through several farms on some of which disease exists, by the farmers themselves visiting the pens and lots where their neighbors have sick hogs, can not be too strongly emphasized. Disinfection of the premises, of the farmer's boots, clothing, of the wagons, etc., are absolutely necessary. Hence in all cases pens and lots should be thoroughly disin-

fectured with lime or 5 per cent carbolic acid, a pure water supply should be secured, and the hogs should from time to time have access to a mixture of salt, sulphur, and charcoal, or this should be put in their food. The animals should also have access to comfortable, well-protected sheds.

STATE SUPERVISION.

The results of the experiments conducted by the Bureau of Animal Industry indicate the advisability of certain State experiment stations carrying out this line of work in cooperation with the Bureau of Animal Industry.

Some expense is necessary for starting plants, building stables, and securing the animals, and a good deal of instruction for the men who undertake the work would be required. At the same time, as these experiment stations were inaugurated in order to advance the agricultural interests of the farmers, as they receive a very large amount of support from the National and State governments, it is presumed that they will gladly cooperate in every effort to promote the interests of the farmer. Undoubtedly commercial firms would be only too anxious to take up the manufacture of these serums, as the loss to farmers from these diseases of swine is so enormous. The moment that products of this sort, which can be so easily put up in a condition that they may be perfectly worthless and still appear satisfactory, are placed on the market for gain, the temptation is so great to sell an inefficient material that very often unsatisfactory results may be obtained and great discredit thrown upon the entire work. If private firms undertake the manufacture and sale of serum for treating swine, their products and prices should be subject to legal supervision. If the public is protected against the sale of utterly worthless fertilizers, as is the case in many of our States, most assuredly the sale of a material which may prove so essential to the farmer should also be subject to legislative control. No lot of serum should be sold unless it had been approved, and its value as a curative agent tested, by careful official inspection and trial. As the Bureau of Animal Industry has now a plant for the manufacture of this material, has obtained a great deal of very valuable experience, and has worked out the theoretical and some of the practical principles of the use of serum which promises such good results in treating swine, it is probable that for several years to come at least those who are working along these lines will prefer that the control of this material should remain either directly in its hands or under its supervision. The Bureau is endeavoring to push the work, and to supply larger and still larger quantities of serum for use, and will carefully note and report the results.